

What is claimed is:

1. A transfer case comprising:
  - an input shaft;
  - a reduction unit driven by said input shaft and having an output member driven at a reduced speed relative to said input shaft;
  - first and second output shafts;
  - a range actuator moveable between first and second range positions to establish corresponding high-range and low-range drive connections between said first output shaft and said input shaft and said output member;
  - a bi-directional mode clutch having a first ring driven by said first output shaft and a second ring adapted to rotate relative to said first ring for selectively coupling said first ring to said second output shaft;
  - a mode actuator moveable between at least three mode positions, said mode actuator is operable in its first mode position to permit rotation of said second ring relative to said first ring in a first direction and prevent rotation of said second ring relative to said first ring in a second direction to establish an on-demand four-wheel drive mode, said mode actuator is operable in its second mode position to permit rotation of said second ring relative to said first ring in both directions to establish a part-time four-wheel drive mode, and said mode actuator is operable in its third mode position to prevent rotation of said second ring relative to said first ring in both directions to establish a two-wheel drive mode;

a shift mechanism for coordinating movement of said range actuator and said mode actuator, said shift mechanism is operable in a first shift position for locating said range actuator in its first range position and said mode actuator in its first mode position to establish an on-demand four-wheel high-range (AUTO) drive mode, said shift mechanism is operable in a second shift position for locating said range actuator in its first range position and said mode actuator in its second mode position to establish a part-time four-wheel high-range (4WH) drive mode, said shift mechanism is operable in a third shift position for locating said range actuator in its first range position and said mode actuator in its third mode position to establish a two-wheel high-range (2WH) drive mode, and said shift mechanism is operable in a fourth shift position for locating said range actuator in its second range position and said mode actuator in its second mode position to establish a part-time four-wheel low-range (4WL) drive mode; and

a control system for controlling movement of said shift mechanism.

2. The transfer case of Claim 1 wherein said mode actuator is fixed for rotation with one of said first and second rings.

3. The transfer case of Claim 1 further comprising a transfer assembly interconnecting said first ring to said first output shaft, said transfer assembly including a first sprocket driven by said first output shaft, a second sprocket fixed to said first ring and operably driven by said first sprocket, said second sprocket arranged to be coaxial with said second output shaft.

4. The transfer case of Claim 3 wherein said second ring is coaxially disposed between said first ring and said second output shaft.

5. The transfer case of Claim 1 further comprising a transfer assembly interconnecting said second ring to said second output shaft.

6. The transfer case of Claim 1 wherein said first ring has a first cam surface and said second ring has a second cam surface, and said mode clutch further includes rollers disposed in rolling contact with said first and second cam surfaces, whereby rotation of said second ring relative to said first ring causes said rollers to ride on said cam surfaces and frictionally clamp said second ring to said first ring and said second output shaft.

7. The transfer case of Claim 1 wherein said first ring includes a first slot and said second ring includes a second slot which is alignable with said first slot to define an actuation chamber having laterally-spaced first and second stop surfaces.

8. The transfer case of Claim 7 wherein said mode actuator is operable in its first mode position to engage said first stop surface in said actuation chamber, said mode actuator is operable in its second mode position to be displaced from engagement with both of said first and second stop surfaces in said actuation chamber, and said mode actuator is operable in its third mode position to engage both of said first and second stop surfaces in said actuation chamber.

9. The transfer case of Claim 8 wherein said mode actuator includes an actuator rod that is moveable relative to said actuation chamber, said actuator rod includes a first segment adapted to only engage said first stop surface when said mode actuator is in its first mode position, a second segment adapted to be displaced from both of said first and second stop surfaces when said mode actuator is in its second mode position, and a third segment adapted to engage both of said first and second stop surfaces when said mode actuator is located in its third mode position.

10. The transfer case of Claim 9 wherein said mode actuator is moveable to a fourth mode position to prevent rotation of said second ring relative to said first ring in said first direction and permit relative rotation therebetween in said second direction, said actuator rod includes a fourth segment adapted to only engage said second stop surface in said actuator slot when said mode actuator is in its fourth mode position.

11. The transfer case of Claim 1 wherein said shift mechanism comprises:

- a range fork for moving said range actuator between its two range positions;

- a mode fork for moving said mode actuator between its three mode positions;

- a movement coordinating member moveable between its four shift positions for causing coordinated movement of said range fork and said mode fork; and

- an electric motor for moving said movement coordinating member.

12. The transfer case of Claim 11 wherein said control system comprises:

a mode selector for permitting a vehicle operator to selected operation in one of said AUTO, 4WH, 2WH and 4WL drive modes and generate a mode signal indicative of the specific drive mode selected; and

a controller for receiving said mode signal and sending an electric control signal to said electric motor in response to said mode signal for moving said movement coordinating member to said shift position corresponding to the drive mode selected.

13. The transfer case of Claim 1 wherein said control system comprises:

a power-operated shift actuator for moving said shift mechanism;

a mode selector permitting an operator to select one of the available AUTO, 4WH, 2WH and 4WL drive modes; and

a controller receiving mode signals from said mode selectors and controlling actuation of said power-operated shift actuator in response to said mode signals.

14. A transfer case comprising:

an input shaft;

a reduction unit driven by said input shaft and having an output member driven at a reduced speed relative to said input shaft;

first and second output shafts;

a range actuator moveable between first and second range positions to establish corresponding high-range and low-range drive connections between said first output shaft and said input shaft and said output member;

a transfer assembly driven by said first output shaft;

a bi-directional mode clutch having a first ring driven by said transfer assembly and a second ring coaxially disposed between said first ring and said second output shaft, said second ring adapted to rotate relative to said first ring for selectively coupling said first ring to said second output shaft;

a mode actuator moveable between three mode positions, said mode actuator is operable in its first mode position to permit rotation of said second ring relative to said first ring in a first direction and prevent rotation of said second ring relative to said first ring in a second direction to establish an on-demand four-wheel drive mode, said mode actuator is operable in its second mode position to permit rotation of said second ring relative to said first ring in both directions to establish a part-time four-wheel drive mode, and said mode actuator is operable in its third mode position to prevent rotation of said second ring relative to said first ring in both directions to establish a two-wheel drive mode; and

a shift mechanism for coordinating movement of said range actuator and said mode actuator.



15. The transfer case of Claim 14 wherein said shift mechanism is operable in a first shift position for locating said range actuator in its first range position and said mode actuator in its first mode position to establish an on-demand four-wheel high-range (AUTO) drive mode, wherein said shift mechanism is operable in a second shift position for locating said range actuator in its first range position and said mode actuator in its second mode position to establish a part-time four-wheel high-range (4WH) drive mode, wherein said shift mechanism is operable in a third shift position for locating said range actuator in its first range position and said mode actuator in its third mode position to establish a two-wheel high-range (2WH) drive mode, and wherein said shift mechanism is operable in a fourth shift position for locating said range actuator in its second range position and said mode actuator in its second mode position to establish a part-time four-wheel low-range (4WL) drive mode.

16. The transfer case of Claim 15 further comprising a control system for controlling movement of said shift mechanism.

17. The transfer case of Claim 16 wherein said first ring has a first cam surface and said second ring has a second cam surface, and said mode clutch further includes rollers disposed in rolling contact with said first and second cam surfaces, whereby rotation of said second ring relative to said first ring causes said rollers to ride on said cam surfaces and frictionally clamp said second ring to said first ring and said second output shaft.

18. The transfer case of Claim 16 wherein said first ring includes a first slot and said second ring includes a second slot which is alignable with said first slot to define an actuation chamber having laterally-spaced first and second stop surfaces.

19. The transfer case of Claim 18 wherein said mode actuator is operable in its first mode position to engage said first stop surface in said actuation chamber, said mode actuator is operable in its second mode position to be displaced from engagement with both of said first and second stop surfaces in said actuation chamber, and said mode actuator is operable in its third mode position to engage both of said first and second stop surfaces in said actuation chamber.

20. The transfer case of Claim 19 wherein said mode actuator includes an actuator rod that is axially moveable relative to said actuation chamber, said actuator rod includes a first segment adapted to only engage said first stop surface when said mode actuator is in its first mode position, a second segment adapted to be displaced from both of said first and second stop surfaces when said mode actuator is in its second mode position, and a third segment adapted to engage both of said first and second stop surfaces when said mode actuator is located in its third mode position.

21. The transfer case of Claim 20 wherein said mode actuator is moveable to a fourth mode position to prevent rotation of said second ring relative to said first ring in said first direction and permit relative rotation therebetween in said second direction, said actuator rod includes a fourth segment adapted to only engage said second stop surface in said actuator slot when said mode actuator is in its fourth mode position.

22. The transfer case of Claim 15 wherein said shift mechanism comprises:

- a range fork for moving said range actuator between its two range positions;

- a mode fork for moving said mode actuator between its three mode positions;

- a sector plate rotatable between said four shift positions for causing coordinated movement of said range fork and said mode fork; and

- an electric motor for rotating said sector plate.

23. The transfer case of Claim 16 wherein said control system comprises:

a mode selector for permitting a vehicle operator to selected operation in one of said AUTO, 4WH, 2WH and 4WL drive modes and generate a mode signal indicative of the specific drive mode selected; and

a controller for receiving said mode signal and sending an electric control signal to said electric motor in response to said mode signal for moving said movement coordinating member to the shift position corresponding to the drive mode selected.

24. The transfer case of Claim 15 further comprising:

a power-operated shift actuator for moving said shift mechanism;

a mode selector permitting an operator to select one of the available AUTO, 4WH, 2WH and 4WL drive modes; and

a controller receiving mode signals from said mode selector and controlling actuation of said power-operated shift actuator in response to said mode signals.

25. A transfer case comprising:

first and second shafts;

a bi-directional mode clutch having a first ring driven by said first shaft and a second ring adapted to selectively rotate relative to said first ring for releasably coupling said first ring to said second shaft;

a mode actuator moveable between three mode positions, said mode actuator is operable in its first mode position to permit rotation of said second ring relative to said first ring in a first direction and prevent rotation of said second ring relative to said first ring in a second direction to establish an on-demand four-wheel drive mode, said mode actuator is operable in its second mode position to permit rotation of said second ring relative to said first ring in both directions to establish a part-time four-wheel drive mode, and said mode actuator is operable in its third mode position to prevent rotation of said second ring relative to said first ring in both directions to establish a two-wheel drive mode; and

a power-operated shift mechanism for controlling movement of said mode actuator.

26. The transfer case of Claim 25 wherein said mode actuator is fixed for rotation with one of said first and second rings.

27. The transfer case of Claim 25 further comprising a transfer assembly interconnecting said first ring to said first shaft, said transfer assembly including a first sprocket driven by said first shaft, a second sprocket fixed to said first ring and operably driven by said first sprocket, said second sprocket arranged to be coaxial with said second shaft.

28. The transfer case of Claim 27 wherein said second ring is coaxially disposed between said first ring and said second shaft.

29. The transfer case of Claim 25 wherein said first ring has a first cam surface and said second ring has a second cam surface, and said mode clutch further includes rollers disposed in rolling contact with said first and second cam surfaces, whereby rotation of said second ring relative to said first ring causes said rollers to ride on said cam surfaces and frictionally clamp said second ring to said first ring and said second shaft.

30. The transfer case of Claim 25 wherein said first ring includes a first slot and said second ring includes a second slot which is alignable with said first slot to define an actuation chamber having laterally-spaced first and second stop surfaces.

31. The transfer case of Claim 30 wherein said mode actuator is operable in its first mode position to engage said first stop surface in said actuation chamber, said mode actuator is operable in its second mode position to be displaced from engagement with both of said first and second stop surfaces in said actuation chamber, and said mode actuator is operable in its third mode position to engage both of said first and second stop surfaces in said actuation chamber.

32. The transfer case of Claim 31 wherein said mode actuator includes an actuator rod that is moveable relative to said actuation chamber, said actuator rod includes a first segment adapted to only engage said first stop surface when said mode actuator is in its first mode position, a second segment adapted to be displaced from both of said first and second stop surfaces when said mode actuator is in its second mode position, and a third segment adapted to engage both of said first and second stop surfaces when said mode actuator is located in its third mode position.

33. The transfer case of Claim 32 wherein said mode actuator is moveable to a fourth mode position to prevent rotation of said second ring relative to said first ring in said first direction and permit relative rotation therebetween in said second direction, said actuator rod includes a fourth segment adapted to only engage said second stop surface in said actuator slot when said mode actuator is in its fourth mode position.

34. The transfer case of Claim 25 wherein said shift mechanism comprises:

a mode fork for axially moving said mode actuator between its three mode positions;

a drive member for converting rotary movement into axial movement of said mode fork; and

an electric motor for rotatively driving said drive member.

35. The transfer case of Claim 25 wherein a control system comprises:

a mode selector for permitting a vehicle operator to select operation in one of said drive modes and generate a mode signal indicative of the specific drive mode selected; and

a controller for receiving said mode signal and sending an electric control signal in response thereto to said electric motor for rotating said drive member to move said mode actuator to the mode position corresponding to the drive mode selected.